REGULATION, INSTITUTIONAL STRUCTURE AND THE PERFORMANCE OF THE POWER SECTOR IN INDIA

Final Report

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Contents

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List of Annexures

List of Abbreviations

APSEB - Andhra Pradesh State Electricity Board
BBMB - Bhakra-Beas Management Board
BIS - Bureau of Indian Standards
BSEB - Bihar State Electricity Board
CEA - Central Electricity Authority
CPCB - Central Pollution Control Board
CPRI - Central Power Research Institute
DNES - Department of Non-Conventional Energy Sources
DOP - Department of Power
DSCR - Debt Source Coverage Ratio
DVC - Damodar Valley Corporation
EDs - Electricity Departments
EIS - Environmental Impact Statement
EMC - Energy Management Center
GOI - Government of India
HPMV - High Pressure Mercury Vapour
HPSEB - Himachal Pradesh State Electricity Board
HPSV - High Pressure Sodium Vapour
HSEB - Haryana State Electricity Board
HT - High Tension
HVDC - High Voltage Double Circuit
ICB - International Compititive Bidding
IPC - Investment Promotion Cell
KEB - Karnataka State Electricity Board
LT - Low Tension
MPNES - Ministry of Power and Non-Conventional Energy Sources
MPSEB - Madhya Pradesh State Electricity Board
MSEB - Maharashtra State Electricity Board
NEEPCO - North-Eastern Power Corporation
NHPC - National Hydro Power Corporation
NLC - Neyveli Lignite Corporation
NPTC - National Power Transmission Corporation
NTPC - National Thermal Power Corporation
PETS - Power Engineers Training Society
PFC - Power Finance Corporation
PIB - Public Investment Board
PLF - Plant Load Factor
PSEB - Punjab State Electricity Board
RE - Rural Electrification
REBs - Regional Electricity Boards
REC - Rural Electrification Corporation
RETs - Renewable Energy Technologies
SEBs - State Electricity Boards
SHB - Small Hydro Power
TOU - Time-of-Use
T&D - Transmission and Distribution
WBSEB - West Bengal Electricity Board

CHAPTER 1

EVOLUTION OF THE INSTITUTIONAL FRAMEWORK

Prior to 1947, the supply of power in India was a predominantly commercial venture undertaken by privately owned utilities located in and around urban areas. There was little co-ordination or co-operation among these private undertakings as their area of activities were isolated and often located far apart. The Indian Electricity Act of 1910 regulated the industry and protected consumer's interests.

At the time of independence, in view of the importance of power in economic development, the government decided to nationalize and restructure the entire power industry. It was in this context that separate comprehensive legislation outside the purview of the 1910 Act was conceived at the time of independence to provide the electricity supply industry with an organizational structure for the state owned sector.

1.1 Creation of state electricity boards and electricity departments

As a result of the Electricity (Supply) Act of 1948, state electricity boards (SEBs) were created in each state[1]. The SEBs were to co-ordinate the development of generation, transmission and distribution of electricity within their states in the most efficient and economic manner. The Act also empowers the SEBs to set tariffs and revise them from time to time. The SEBs are envisaged to function as an autonomous body and the Act provides for the state governments to give directions, if necessary on matters of policy to guide the functioning of the boards.

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[1]Under the Indian Constitution, Indian is divided into states who have their own government, and union territories, who are governed by the central government.

In union territories, electricity departments (EDs) were set up and local governments are responsible for power development. In the states of Manipur, Nagaland, Sikkim and Tripura, electricity supply is the responsibility of departmental organizations. Presently there are 18 SEB's, 13 state/union territory electricity departments and one municipal corporation in the 25 states and 7 union territories in India.

In several states, licensees already engaged in generation and distribution of power were allowed to continue in business so long as their licenses were valid. Presently there are 57 distribution licensees operating in the country. Of these, 5 are engaged in power generation as well. These private utilities are: Tata Electric Company, Calcutta Electricity Supply Company, Ahmedabad Electric Company, Gujarat Industrial Power Corporation Ltd., and Andhra Pradesh Gas Power Corporation.

The share of private companies in total installed capacity has declined significantly from 30 percent in 1960-61 to 3.7 percent in 1988-89. The share of energy sales by private sector declined from 20.5 percent in 1960-61 to 8 percent in 1988-89. Trends in ownership wise installed capacity and energy sales (utility only) in the country is given in Annexures 1.1 and 1.2 respectively. In addition to the privately owned utilities, there are privately owned captive power plants operated for owner's use. The existing capacity of captive plants (both private and public sector), as on 31st March 1989 was about 7420 MW.

1.2 Central government's involvement in power generation

The involvement of the central government in conventional power generation began as part of an overall river valley development programme in the Damodar river basin. The Damodar Valley Corporation (DVC), a statutory organization, was established for this purpose in 1948 under the central government, with equal participation by the state governments of Bihar and West Bengal.

The DVC is responsible for power supply in the Damodar Valley area, supplying power directly to consumers who draw at voltages of 33 kV and above, and to others through the SEBs in Bihar and West Bengal.

In the mid-1950s, the central government also took over the integrated development of lignite mines at Neyveli in Tamil Nadu (southern region), including power generation based on lignite. The Neyveli Lignite Corporation (NLC) was established in 1956 under the Companies Act, and now functions administratively under the Department of Coal (GOI). NLC supplies power in bulk to the state electricity boards.

The Bhakra-Beas Management Board (BBMB) manages the inter-state river valley projects of Bhakra and Beas. It operates six hydroelectric power stations with a total installed capacity of 2,704 MW in the Sutlej-Beas river basins in the northern region, manages the operation of an extensive network of transmission lines in the western part of the northern region, and delivers power to the participating states according to allocated shares.

The Atomic Energy Act of 1962 vests the responsibility for nuclear power development with the central government. Until recently, this responsibility was discharged by a departmental organization, the Nuclear Power Board. To give it more flexibility the organization was subsequently reconstituted as a corporation, the Nuclear Power Corporation (NPC). The NPC maintains and operates nuclear power plants in the northern, western and southern regions and supplies power in bulk to SEBs.

1.3 Regional approach

During the 1960s, the advantage of extending power system integration from the spatial limits of states to regions of contiguous states were recognized. Thus in 1963, India was divided into five regions. Regional Electricity Boards (REBs) as associations of constituent SEBs and other power utilities in the

respective regions, were created through central government resolutions. REBs are voluntary associations with their secretariats being administratively under the Central Electricity Authority (CEA). REBs coordinate generation schedules of generating companies and maintenance programmes, monitor systems operations and help arrange inter-state power exchanges. The five REBs are:

(i) Northern Region Electricity Board - comprising Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Rajasthan, Uttar Pradesh, Delhi and Chandigarh.

(ii) Western Region Electricity Board - comprising Gujarat, Madhya Pradesh, Maharashtra, Goa, Daman & Diu and Dadra & Nagar Haveli.

(iii) Southern Region Electricity Board - comprising Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Pondicherry and Lakshadweep.

(iv) Eastern Region Electricity Board - comprising Bihar, Orissa, Sikkim, West Bengal and Andaman and Nicobar Islands.

(v) North-Eastern Region Electricity Board - comprising Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura.

Though the REBs have been in operation for more than 28 years, it is only recently that they have been given the powers necessary to exercise effective control over the generating units and transmission lines in the region. According to the amendment of the Electricity (Supply) Act 1948, in August 1991, every licenser and generating company shall follow all the directions of the REBs and shall conduct their operations in accordance with the instructions of the Regional Load Despatch Centre so as to ensure integrated grid operations.

1.4 Generating companies

The need to supplement the efforts of the SEBs was felt in the early seventies, when power shortages were felt in several states. In 1976, the Electricity (Supply) Act was amended to provide for the establishment of generation companies by central and the state governments. In 1975, the central government created the National Thermal Power Corporation (NTPC) and the National Hydro-electric Power Corporation (NHPC) for thermal and hydroelectric development in the country. NTPC and NHPC generate and supply power in bulk to the SEBs and EDs according to allocated shares. NHPC is also responsible for distribution of power imported from Chukha hydroelectric plant in Bhutan. A regional corporation, the North-Eastern Power Corporation (NEEPCO), was created in 1976 to provide for the special needs of the northeastern region.

Besides these central government established corporations, some of the state governments also established power corporations responsible for power generation. However, in most of the states these corporations were set up to construct the power plant, which was on completion handed over to the respective SEBs for generation and distribution. For example, Orissa Power Generation Corporation Ltd., Uttar Pradesh Rajya Vidyut Utpadan Nigam Ltd., and Karnataka Power Corporation (KPC is responsible for generation also). To accelerate hydroelectric development, the central government also established special joint corporations with some of the state governments e.g. Nathpa Jakri in Himachal Pradesh and Tehri in Uttar Pradesh.

1.5 National Power Transmission Corporation

The National Power Transmission Corporation (NPTC) was established in 1989-90 with a view to a formation of a national grid, and integrating the grids in the five regions. It became operational with the take over of the construction of new bulk transmission lines and major inter-regional and intra-regional lines (mostly 440 kV, but some 220 kV lines also). The important

tasks assigned to NTPC are:

(i) to take over the completed, operational and ongoing transmission projects under the central sector generating companies including the Nuclear Power Corporation;

(ii) to take over the operations of regional load despatch centers in all the regions, expand and modernise their facilities to enable them to ensure greater reliability in grid operation and to ensure utilisation of the generating capacity in the region and the country in an optimum manner;

(iii) to pool power from central generating companies and sell them to the beneficiary states in the region ensuring that all states get their due share.

1.6 Nodal organisations

The overall responsibility of power development lies with the Department of Power (DOP), under the Ministry of Power and Non-Conventional Energy Sources (MPNES), Government of India. DOP is responsible for formulating policy and plans for the power development, processing power projects for investment decisions, training and human resource development and administrating any legislation pertaining to power generation and supply. DOP provides the linkage between the other ministries/departments in the central governments, Planning Commission and the state governments. The Department of Non-Conventional Energy Sources (DNES), is a nodal agency for planning and implementing the new and renewable energy sources programme. DNES in consultation with the state nodal agencies, has been making efforts to promote these technologies.

The Central Electricity Authority (CEA) is a statutory body set up under the provisions of the Electricity (Supply) Act, 1948 under the Department of Power. It was established as a part-time body in 1951, as a part of Central Water and Power Commission. It formally became a full-time body in 1974. CEA was set up with the prime objective of coordinating the activities of the power sector in the

country. Some of the important responsibilities of CEA are:

(i) to develop a sound, adequate and uniform national power policy;

(ii) formulate short-term and prospective plans for power development;

(iii) coordinate the activities of the planning agencies in relation to the control and utilization of power resources;

(iv) act as arbitrators in matters arising between the state governments, the boards and the licensees.

CEA is also responsible for promoting the integration of the state's power systems and for providing technical support to the SEBs.

As a part of its rural electrification programme, the central government established the Rural Electrification Corporation (REC) in 1969. This is a specialized development financial institution at the national level, responsible for financing and monitoring rural electrification programmes. More recently, the Government established the Power Finance Corporation (PFC) to assist high priority power projects by insulating them from the budgetary constraints of the central and state governments. DOP has setup the Central Power Research Institute (CPRI) and the Power Engineers Training Society (PETS) under its administration. The CPRI was established in 1960, under Central Water and Power Commission, to serve as a national laboratory for applied research in electrical power engineering and also to function as an independent authority for testing and certification of electrical equipments manufactured in the country. It was organised as autonomous society in 1978. PETS was established as an autonomous body in 1988 to function as an apex national body for meeting the training requirements of the power sector in the country. The hierarchical position of the various organizations in the India's power sector is illustrated in Figure 1.1.

1.7 Electricity privatisation

In June 1990, Ministry of Energy announced a policy decision of allowing private sector participation in power generation. The basic objective of this long awaited move is to bring in additional resources for investment in power supply facilities and thus partly make up the shortfalls. Further, private sector participation is expected to bring in increased efficiency in the operation of the power sector.

Till recently private sector participation in power sector was mainly in the form of licensees for distributing power. Today, there are 57 distribution licensees operating in the country. Of these only five private utilities have generation capacity totalling 2763 MW. With the amendments to the Electricity (Supply) Act 1948, private sector is now allowed to participate in power generation, as "Generating Companies", like NTPC and NHPC. It is envisaged that generating companies may sell power to SEBs by entering into contractual agreement for specific periods. The other alternative available in this regard would be to entrust the generating company with the responsibility of supplying power to an area comprising a proper mix of industrial, commercial, domestic consumers, so that they are assured of receipt of revenues of a fairly reasonable portion of the power generated. The advantages of this option are that this would improve the quality of power supply to their consumers and would help in the improvement of the existing distribution system.

However, this also suffers from the disadvantage that SEBs would be deprived of some portion of their bulk consumers from whom they probably receive regular payments, and they would be left with largely unremunerative categories of consumers like domestic, rural and agricultural loads etc. Probably the ideal solution would be to have a mix of the above two options, i.e., private generating companies could be allocated a portion of bulk industrial loads as

their direct consumers, and their balance generation could be sold to the SEBs, who in turn would have their fair share of bulk consumers. Ultimately when the NPTC becomes fully functional and their concept of purchasing power from all power producing agencies, viz NTPC, NHPC, SEBs, etc. is implemented, at that time private generation companies could also join the pool.

Unlike in the previous plans, the SEBs and the state governments as well as CEA are now encouraging the industries to set up captive power plants. Private sector may come forward to set up 60 MW or 120 MW coal-based captive generation plant at load centres, which could supply electricity to a cluster of industries in the region, wheeling power over the SEB grid network. Also, captive power plants set up by the private enterprises will be permitted to sell or distribute their surplus power to SEBs.

The power development being highly capital intensive and having long gestation period, it may normally not attract sufficient private response and funding. Government has, therefore, tried to offer certain incentives to attract private sector participation in power generation. The highlights of the government policy are:

(i) Debt equity ratio of 4:1. This would mean that a minimum of 20 per cent of cost should be equity and out of it at least 11 per cent to come through promoters contribution. To ensure additional resources mobilisation, it is stipulated that at least 60 per cent of the outlay to come from sources other than public financial institutions such as nationalised banks, Life Indusrance Corporation, Industrial Development Bank of India, etc.

(ii) Increase in the prescribed rate of return from the existing 2 per cent above the RBI rate to 5 per cent above the RBI rate.

(iii) Capitalisation of interest during construction at the actual cost (instead of at present 1 per cent above the RBI rate) for the initial project as well as for the subsequent projects.

(iv) Period of initial validity of license increased to 30 years from existing 20 years and subsequent extension for 20 years on each occasion.

(v) Exemption to private licensees from obtaining clearances under MRTP Act.

(vi) Upto 100 per cent foreign equity participation permitted for projects set up by foreign private investors.

(vii) With the approval of the Government, import of equipment for power projects will also be permitted in cases where foreign supplier(s) or agency(ies) extend concessional credit.

Investment Promotion Cell (IPC) in the Department of Power has been set up to directly interface with prospective private enterprise entrants to the electricity sector and help them in getting clearances. A high-powered board has been formed under the Chairmanship of Cabinet Secretary to the government, to monitor the clearance of projects. This will ensure that statutory clearances are obtained and any outstanding issues resolved within a specific time frame.

CHAPTER 2

POWER SECTOR REGULATIONS

2.1 Planning

Electricity is a concurrent subject in the Indian Constitution, in which the decision making and implementation involves both the central/federal and the state/provincial governments. Traditionally, the central government provides the policy guidelines and regulatory and planning framework and the state governments are responsible for power development, generation and supply.

Formulation of individual projects is mainly carried out by the SEBs or other owning and operating agencies. For all the power projects where the cost exceeds Rs. 10 million a statutory clearance by CEA is required before the project can be implemented. While according technical clearances, CEA is required to ensure optimality of the projects from the operational point of view taking note of both short term and long term perspectives. In addition, CEA is also required to make sure that the project yields a reasonable rate of return. In the case of hydro projects the CEA is further required to ensure that the proposed project does not prejudice the interest of other potential uses of water i.e. for irrigation, flood control, navigation etc. All multi-purpose river water projects are first appraised by the Central Water Commission. After clearance from CEA, the project is appraised by the Ministry of Forests and Environment for environmental clearance. The environmental regulations are discussed in detail in section 2.2.

The final clearance on the project is given by the Planning Commission for state government projects and the central cabinet in the case of central government projects. Any central government project, costing more than Rs. 50 million requires cabinet approval following clearance by the Public Investment Board (PIB). Details

of major clearances required for setting up a project in the electricity sector is given in Annexure 2.1.

While the planning for the power development is carried out by CEA, the resource allocation for all sectors of economy is done by Planning Commission. Once a project is included in the Five-Year Plan, there is a virtual guarantee of funds to cover costs irrespective of any time or cost overruns that may occur. However, there is considerable uncertainty regarding the amount of funds that would "actually" be made available to the power projects, especially the ones in the state sector, during the different years of the Plan (this is in fact a major factor contributing to cost escalations and delays in projects). The reason is that the year-wise allocation of funds made at the beginning of a plan period is quite tentative and the actual allocation gets considerably modified in every annual plan. Whenever there is an overall resources crunch or the actual resource mobilization does not match the expectations, the overall allocations made to the power sector, as well as the allocations made to different projects within the sector are considerably modified. In such situations, on-going projects or projects nearing completion normally receive priority. Thus, the SEBs have no assurance of timely availability of investment funds to them particularly when most of the state governments have deficit budget.

This non-availability of assured investment funds over a long-range planning forces SEBs to carry out their investment programmes in an ad-hoc manner based on short-term considerations. In order to circumvent this problem, the SEBs try to include many new schemes in each plan period, by possibly under-estimating their investment costs. The idea is that once a project is included in the plan, it would be seen through, whatever may be the cost escalations or delays in commissioning. Moreover, the new schemes in each plan would become on-going schemes in subsequent plans and would receive priority in the allocation of the limited resources.

This results in spreading the limited resources available rather thinly over many projects.

2.2 Environmental regulations

All power stations (as do other sectors of the economy) have to submit Environmental Impact Statements (EIS) to the Ministry of Forests and Environment to obtain clearance for power projects. These statements give information on the steps taken to maintain emission levels in the case of thermal and nuclear stations, and regarding protection of the environment and resettlement and rehabilitation of the population in the catchment areas for hydro power stations. Even the transmission lines have to be cleared regarding right of way through forests etc. Despite the steps taken by the Ministry, the utilities have not really realized the seriousness of the problem. The chapters containing steps for controlling emissions are usually sketchy and power projects get delayed for reasons of not providing adequate data in this important area. Large hydro projects have of late attracted the attention of environmental groups who have (rightly or wrongly) taken the issue of environmental damage by large hydro power projects beyond proportions. In the entire process, the only thing that happens is that the project gets delayed by several years and leads to cost overruns as well.

The power sector presently accounts for about 50 percent of all the emissions responsible for global warming in India. This includes CO_2, CO, SO_2, and NO_x emissions. Among the various emissions released by combustion, CO_2 emissions are the most critical. In 1986, the Central Pollution Control Board (CPCB)in India formulated a legislation which specifies the emission standards for thermal power stations. For keeping the oxides of sulphur (SO_x) and nitrogen (NO_x) emissions levels within the limits prescribed in the ambient air quality standards, it warrants a minimum stack height. Control levels required for air and water emissions as per current CPCB standards are listed in Annexure 2.2 and 2.3.

Bulk of Indian coal is characterized by high ash (30-40 per cent) but low in sulphur content (below 0.5 per cent) and thus produces large quantities of fly ash and bottom ash, on combustion. In order to control the particulate matter in flue gas electro-static precipitators (ESPs) have been installed in almost all the new power stations. Although there have been some problems regarding the operations of ESPs, their performance by and large has been satisfactory. The Bureau of Indian Standards (BIS), in close cooperation with the concerned ministries, is in the process of bringing out the necessary standards.

The solid waste products of coal combustion - fly ash and bottom ash - pose a major waste disposal problem because of large areas of land that are required and the consequent deterioration of soil. Given the high percentage of ash in Indian coals, it has been estimated that between (30-40) million tonnes of ash are generated annually[1]. Attempts are being encouraged for alternative use of fly ash in making bricks, cement and in road construction.

The environmental consequences of hydroelectric power projects encompass a wide area that includes the physio-chemical, biological and social environment. The major concerns are: (i) displacement and resettlement; (ii) loss of forests; (iii) sedimentation of reservoirs; (iv) spread of water[1] borne diseases; (v) water logging and salinity resulting in root damage and reduction in crop yields.

The operation of nuclear power plants gives rise to wide variety of fission and activation products. Depending upon dose levels, exposure to radiation can have somatic as well as genetic effects. Possibility of accidental releases of radio nuclides and

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[1] Gupta, T.N., et al., 1992, use of fly ash and ash slurry, background paper for the International Conference on Environmentally Sound Coal Technologies, Madras, January 15-28.

decommissioning of nuclear plant are important environmental concerns.

The government of India has constituted a working group and several sub-groups to identify the various options that would go towards working out strategies to contain the damage to the environment from the power sector. These relate to identification of strategies for improvement in generation, transmission and distribution efficiencies.

2.3 Finances

The source of investment funds for SEBs comprise of state government loans, loans from financial institutions, open market borrowing, internal sources, and central assistance. The open market borrowing of SEBs are governed by Planning Commission and state government decisions and are fully guaranteed by the respective state governments. The state government loans and the institutional loans available to SEBs are again decided by the respective state governments. There is virtual guarantee of funds to cover costs irrespective of any time or cost over runs that it may suffer.

The existing capital structure of the SEBs is entirely debt based. There is no equity contribution from the state governments and the only equity available is reserves, surplus, and consumers contribution towards capital assets and grants and subventions from the government towards capital assets. However, this equity does not take into account the accumulated losses, which if accounted for would make the net worth of most of the boards negative. The pattern of financing capital expenditure for various SEBs during FY1989 is given in Annexure 2.4.

A capital structure having a very high ratio of debt to equity would necessarily need substantial cash flow ability to service the debt. The ability of the boards to service their debt is evaluated

in terms of the debt service coverage ratio (DSCR) and is defined as the ratio of the profit before interest and depreciation to interest payment and loan repayment. DSCR of several utilities has declined over the years. The DSCR for all the boards put together has declined from 0.25 in FY1988 to 0.22 in FY1989 and further to 0.18 in FY1990. Annexure 2.5 gives the details of DSCR of various SEBs during the period FY1988-90.

The boards, in general, have not defaulted on repayment of loans to institutions. Most of the borrowings are guaranteed by the state governments. The repayment liabilities to the institutions are often met out of capital receipts from state governments, future institutional and market loans. State governments tend to adjust the interest due to them from the subsidy payable and the plan allocation of the boards, thus severely affecting the liquidity of the boards. Since the current expenditure can not be deferred, the Boards tend to curtail the capital expenditure, with delaying effect on the projects, resulting in time and cost overruns. In case of thermal power projects cost over runs are generally of the order of 60-100 percent. For hydro power projects, the percentage cost over runs are much higher.

The existing arrangements of very high state government debt and non-payment of interest and loan instalments by the SEBs, has resulted in excessive dependence of SEBs on the state governments. This is one of the important factors that has lead to the dilution of the autonomy of SEBs.

In July 1986, the Power Finance Corporation was established with the main objective of raising extra-budgetary resources to finance generation, transmission and distribution projects, renovation and modernization projects, system improvement and energy conservation projects. PFC stipulates certain conditions or the financial position of SEBs so that they can meet their debt-services obligations.

2.4 Tariffs

The electricity tariffs of the SEBs are primarily based on consideration contained in the section 23 of Indian Electricity Act 1910, and sections 40 and 59 of the Electricity (Supply) Act of 1948. As per the Act the board has to carry on its operations, as far as practicable, without incurring losses and the board could adjust its tariffs from time to time. The Act did not mention any surplus that the board was expected to generate. The Electricity (Supply) Act 1948 was amended in 1978 to make SEBs commercially viable and to earn a net return on their investment. In accordance with the amendment, SEBs were to carry their operations and adjust tariffs as to ensure that total revenues in any year shall have such surplus as the state government may from time to time specify. There was another amendment to the Act in 1980, which specified that the SEBs should earn a net return of 3 percent on the net assets as at the beginning of the financial year. However, as can be seen from Annexure 2.6 most of the SEBs in past years have not been able to achieve the prescribed rate of return of 3 percent.

None of the state governments impose a mandatory rate of return on SEBs. Rather, the emphasis is on providing power for agricultural and industrial development at affordable rates. Most tariff policies and revisions have been guided more by social and/or political considerations rather than financial and national economic efficiency objective. The agricultural sector and the low income domestic consumers are heavily subsidised in all the utilities.

Apart from the overall tariff being much below the average costs, another important feature of the agricultural tariff is that it is framed in the form of a "flat rate" tariff. The consumers in this category are charged a flat rate based on their connected load irrespective of the number of hours used or energy consumed. This has encouraged misuse and wastage of electricity. There are several

instances of farmers running small industries on agricultural connection.

The high-tension (HT) industrial and HT commercial consumers are supplied electricity at a rate higher than the average cost of supply, in order to cross subsidize the domestic and agricultural consumers. However, they can only partly make up the losses and the overall average revenue realized per unit of electricity sold is less than the average cost of supplying electricity in most of the boards. During the FY1990, the ratio of average revenue realized to average costs of operation was less than one for all the boards. Only two boards had this ratio close to unity: 0.98 in case of APSEB and 0.97 in case of OSEB. In four out of 18 SEBs, the ratio was less than 0.5 (refer Annexure 2.7). At the all-India level, this ratio has declined from 0.80 in 1988-89 to 0.77 in 1990-91 (refer Table 2.1).

As a result of these policies, many SEBs incur heavy financial losses and are unable to generate sufficient resources to finance the additional investments required by the increased growth rates in the demand for energy. During the period 1985-90, the total commercial loss (excluding subsidies) for all the SEBs was Rs.117,940 million.

Table 2.1: Average revenue and average cost (all-India)

Year	Average revenue (paise/kWh)	Average cost (paise/kWh)	Average revenue/ average cost (paise/kWh)
1988-89	74.4	93.4	.80
1989-90	80.6	101.5	.79
1990-91	80.9	104.8	.77

Tariff revisions by SEBs are generally carried out on an adhoc basis. The additional costs to be recovered are calculated first. Based on this, the extent to which rates for HT consumers is to be raised is decided. The balance costs to be recovered is then adjusted to the extent possible from LT industrial, commercial and domestic consumers. The agricultural consumers are subject to tariff revisions only if there is no other alternative. Though all the boards have a fuel adjustment clause in their tariffs, the increase in costs is generally passed on to all categories other than LT industry, domestic and agriculture categories. Gujarat Electricity Board (GEB) is the only board where fuel cost increases are passed on to all consumers categories.

While setting the prices for electricity for various consumer categories, a more equitable trade-off between the various pricing objectives is required. All SEBs should earn the mandatory 3 percent rate of return. While the principle of cross subsidization is acceptable, there is a limit to which this can be continued. Each consumer category should pay the cost of supplying electricity to them, and cross subsidization should be within the category among various consumption blocks. Recently the central government has put forward a proposal to all the state governments to raise the agricultural tariffs to a minimum rate of 50 paise/unit. The response of the states to this proposal is awaited.

2.5 Management

The Electricity (Supply) Act provides for the constitution of the state electricity board and also specifies the functions of the board, the Chairman and Members of the board. While the board is to function as an autonomous and commercial undertaking, with the power to fix tariffs and to carry on the operations of the board, the boards require approvals from time-to-time from the state government, as given in the different sections of the Act. The areas include finance (loan approvals, approval of the accounts of the boards), appointment of members of the board, as well as the

details of costing of generation for licensees. The Act provides for these regulations keeping in view the principle of checks and balances. The Act also specifies the powers that the boards have for right of way, land acquisition, etc. The accounts of the boards, duly audited, have to be placed on the floor of the state legislature.

As against these controls, the boards are quite free to carry on their day-to-day operations relating to generation, transmission and distribution, billing, collections, staffing etc. The boards can design strategies for management of the boards functions, carry out feasibility for new projects, surveys for new hydro projects, draw up power plans for submission to CEA and also carry out construction of new power stations and Transmission Lines.

Inter-state exchanges and the share of power from central sector power stations are managed by the board in coordination with the regional electricity boards through the different operational committees that meet on a monthly basis. The boards and the other generating companies manage inter-system exchanges in coordination with the REBs. The SEBs have their load despatch centers who monitor loads and decide on generation, and exports/imports in consultation with the REBs. While all the constituent members agree in principle on the principles of economic load despatch or merit-order generation scheduling, implementation does have limitations.

Apart from the board being the vehicle for implementation of the social objectives of the state governments, there is also the issue of interference by the political setup in the day-to-day affairs of the board such as staffing, purchases, priority in release of connections, not being able to disconnect consumers who do not conform to the boards' rules and regulation, etc. The boards are also constrained financially in terms of not being able to collect from consumers for supply of electricity, while major supplier like coal, railways, power purchases, gas and others are

pushing for advance payment or payment through irrevocable letters of credit.

Inspite of the constraints in the management that the boards have to operate under, one fact must be noted - power generation continues and the economy's lifeline is not disturbed.

CHAPTER 3

POWER POLICY OBJECTIVES

3.1 Electrification objective

3.1.1 Installed capacity

The power supply industry is India has registered a phenomenal growth during the past four decades. The power generating capacity of the country has increased from 2,300 MW in 1950 to 66,894 MW by the end of FY1990, registering an average growth rate of 8.8 percent per annum. Of the 66,894 MW commissioned until 31st March 1991, more than 50 percent had been added during the past ten years alone. Growth in installed capacity in utilities since 1950 is shown in Annexure 3.1. The hydro-thermal capacity mix has changed substantially since the early seventies, with the share of hydro capacity declining from 1:1.25 during the 1960's to 1:3 in 1990. The prime objective of meeting the rapidly increasing demand for electricity has resulted in greater emphasis on the thermal generation because of relatively shorter gestation period of thermal power projects. The average gestation period of thermal projects is 5-6 years where as that of hydro projects is 8-10 years or even longer in several cases.

Technological development and resultant economies of scale has seen an increase in the unit size of generation units, particularly that of thermal units. Larger generating units have lower capital costs and lower operating costs due to higher efficiencies in heat utilization. Where as till 1960, the largest size in use was a set of 90 MW, today, 210 MW and 500 MW sets have become common. Of the 281 thermal units operating in the country as on 31st March 1989, 55 units were of 110/120 MW capacity, 78 units were of 220/210 MW capacity and five were of 500 MW capacity. Details of number of units in different capacity groups is given in Annexure 3.2.

In addition to the choice of type of power stations, the location of the power stations is also very important. Earlier power stations were constructed close to load centres. Today, however the emphasis has shifted to pit-head locations as moving large quantities of coal from the pit-head to a plant close to the load centre pose formidable operational problems, including that of heavy investment in the railway system. However, excessive concentration of power plants at pit-head will have serious environmental consequences and therefore location of the power station must be decided based not only on economic but on environmental factors as well.

3.1.2 Transmission and distribution system

As a result of the policy of constructing power plants at pit-head rather than load centres, the transmission system is also getting increasingly large and sophisticated. From 110 kV in the mid-seventies, the maximum voltage for HT transmission has been increased to 400 kV. Proposal for establishing 750 kV lines for transmitting bulk power across regions are nearing finalisation.

The basic transmission and distribution configuration today is a 400 kV network as the main and bulk transmission system in each region; 220 kV, 132 kV and 110 kV network as the main and support transmission systems in each state; 66 kV, 33kV and 22 kV net work as sub-transmission systems; 11 kV network as primary distribution systems; and 400 V (three-phase) and 230 V network as local distribution systems. The major emphasis hitherto has been to use AC technology. HVDC technology is being introduced for back-to-back interconnection between the northern and western regional systems and also for bulk transfer of power in the northern region. Uptil now, one HVDC line has been established between Singrauli and Dadri in the northern region, for bulk transfer of power to the Delhi area from the Singrauli area in central India where there is a concentration of pit-head super thermal power stations.

Annexure 3.3 presents data on the total circuit-kilometers of T&D lines, as on 31st March 1980 and 1988. The total T & D network expanded by about 6 percent per annum during the 1980s. This growth rate is lower than for generating capacity additions, and reflects the fact that investment in the T&D system has been less than the desired level (less than 40 percent of the total planned investment in the power sector, compared to a desirable level of about 50 percent, as recommended by the Government of India's Committee on Power in 1980). As a result, the generation levels of certain power stations (for example, Singrauli and Rihand Thermal Power Station in the northern region) have had to be curtailed because not all the required 400 kV lines had been commissioned.

3.1.3 Consumption

Electricity consumption in the country has grown at an annual compound rate of 9 percent during the period FY1950 to FY1988. The per capita consumption of electricity, which was only 15 kWh in FY1950 has grown to 236 kWh in FY1989. Among the various consumer categories, growth of electricity consumption in the agricultural sector has been phenomenal. Because of severe drought during the period 1965-67, government laid great emphasis on energization of pumpsets for irrigation. Electricity consumed by agricultural sector has grown at a compounded growth rate of 13.6 percent per annum during the period FY1965-89. Its share in total electricity consumed in the country has increased from 7 percent to 25 percent during the same period. On the other hand, share of industries has declined from 70.6 per cent in FY1965 46.3 percent in FY1989.

After agriculture sector, the rate of growth of electricity consumption has been highest in domestic sector - about 10 per cent per annum. The share of this sector in total energy consumed has almost doubled from 8.8 per cent in Y1965 to 16.1 per cent in FY1989. Commercial sector accounts for 5 to 6 per cent of the total

electricity sales. Composition of sale of electricity to different consumer categories is given in Annexure 3.4.

Both the central and the state/union territory Governments give high priority to rural electrification (RE) programmes. The primary objective is to ensure increased agricultural output by providing power for irrigation pumps, involving mostly ground water pumping by individual farmers. A secondary objective is to provide electricity for domestic, commercial and small industrial consumers and for street lighting in the villages, thereby improving employment opportunities and the quality of life in the rural areas.

The RE programmes are financed directly by the state governments and the Rural Electrification Corporation (REC). Each SEB prepares, alongwith a generation and transmission program, a distribution and rural electrification programme for each Five-Year Plan. This programme is developed on the basis of targets for extending electricity to villages and number of pumpsets. Simultaneously, the Planning Commission prepares a five-year expenditure plan for RE on a nationwide basis. The two approaches are then reconciled in discussions between the state, REC and the Planning Commission, and annual programmes and allocations are formulated for each state.

While the REC initially concentrated on extending feeders to the rural areas and on energizing pumpsets, it now focuses on providing electricity to hill, tribal and desert regions. When inadequate investment creates weaknesses in the sub-transmission networks, REC finances the supporting networks to further RE programmes as well.

The total number of villages electrified increased form 3061 in 1950-51 (0.54 percent of the villages in existence at that time) to about 481,898 by the end of July 1991 (83.8 per cent of the

existing villages). The performance of individual SEBs in providing RE varies widely. The states of Punjab, Haryana, Kerala and Tamil Nadu had achieved 100 percent rural electrification by the end of FY1987. The achievement of RE has been maximum in the southern region.

3.2 Substitution between different primary energy resources

3.2.1 Accelerated hydro power development

Until the mid-1960s, power development in India, was planned keeping in view the basic objective of developing hydel projects and filling in gaps by thermal capacity. Several multi-purpose projects with hydro electric power as one of the important components and single-purpose hydro-electric projects were included in the first three Five-year plans (FY1950-65). Several large run-of-river type hydro projects in the Himalayas were initiated during the 1960s. As a result of these efforts, the share of hydro power projects in the total installed capacity increased from 32.6 percent in FY1950 to 45.6 per cent by the end of third plan (FY1960-65).

However, after the mid 1960's, the hydro electric development lagged behind for a variety of reasons, including inter-state disputes on sharing of water, rising costs, inadequate funding, delays in decision-making regarding land acquisition, non-standardisation of unit size and plant design, inadequacies in construction management, contractual problems, environmental aspects etc. Therefore, augmentation of thermal capacity was considered necessary to produce power in a shorter time period to match the rapidly increasing demand for electricity.

According to recent estimates, India's total economically exploitable hydro electric potential is 396.4 TWh of annual energy generation or about 75,400 MW at 60 percent load factor. Approximately one-fifth of this potential has been developed so far. Most of the unexploited potential is concentrated in the

northern and northeastern regions (about 48,000 MW). Low demand for electric power impedes development of hydroelectric projects in the northeast. Over 60 percent of the potential in the southern region has been developed so far.

Given the Indian energy situation, which is characterized by severe peaking shortages, it is necessary to restore the confidence in hydro development, ensure availability of modern technology for investigation and construction of hydro projects, rationally view the concerns of environmentalists and carefully select some major sites for early development. The share of hydro power in the overall mix of capacity at all India level needs to be improved from the present level of 28 percent to at least 34 percent over the period of next 15 years.

Further, the possibilities of developing hydro resources with collaboration and cooperation of neighbouring countries needs to be explored. Successful cooperation has already been achieved in certain cases. The development of Chukha Hydro Power Project benefits both Bhutan and India. India and Pakistan negotiated the Indus Valley Treaty for cooperation in the management of the valley resources of the Indus river and its tributaries common to both countries. India also assisted Nepal in constructing projects by providing both financial assistance and engineering and construction services. Further projects between India and Nepal, including major schemes now being studied such as Karnali (3,000-6,000 MW) and Pancheswar (2,000-3,000 MW), would benefit both countries, by reducing Nepal's trade deficit with India and supplying less expensive electricity to India's frontier areas. Moreover, hydropower projects would provide the added benefits of increased flood control and irrigation.

While cooperation has been achieved in some situations, the difficulties in managing these projects and in sustaining the political will to develop them are great. It is expected that as

opportunities for developing the more accessible sites are exhausted, efforts towards collaborative projects will be enhanced.

3.2.2 Increased use of natural gas for power generation

As of 1990, the proven and indicated balance recoverable reserves of natural gas in India are 686 billion cubic meters (bcm). These reserves are located mainly along the west coast between Gulf of Cambay and Bombay and in the northeastern region in Upper Assam. However, a significant part of the natural gas produced in the country continues to be flared. During 1989-90, 5130 million cubic meters 28 per cent of the gross production of natural gas was reported to have been flared.

Presently, the share of gas based power generation in the country is very small. In 1989-90 the share of gas based installed capacity in the country was 2.7 per cent and its share in total power generation was only 1.2 per cent. All the gas presently flared off in the west coast could be utilized for power generation in the western region. This would reduce the need for coal, and hence reduce CO_2 emissions. Over 4 billion cubic meters of natural gas being flared in the Bombay High basin annually can generate about 12,000 GWh of electricity which implies an installed capacity of about 2,200 MW of gas based combined cycle TPS. Over 7700 MW of gas based capacity is proposed to be added during the VIII Plan (1992-97).

The use of gas for power generation has, however, to be carefully evaluated considering its availability and its alternative uses of value added potential in other sectors of economy. Gas is required to replace large quantities of oil being used in the transport sector and kerosene oil and fuel wood used in the household sector. Fuel oil used in industry for heating and steam raising has also to be replaced with gas wherever it is available. The requirement of gas for fertilizers and petrochemicals must also to be taken into account while considering its use in power generation.

3.2.3 Renewable energy technologies

Renewable energy technologies (RETs) being environmentally more benign as compared to conventional power generation options, have strong substitution possibilities. Small and mini hydel plants, biogas and wind electric generation in the grid connected mode are likely to play a significant role in future. The extent to which a given RET will actually get installed depends on several factors like the state of technology, future developments, government policies, economics of generation, infrastructure, industrial capability, organisational and institutional aspects, availability and channelisation of funds and the turnover capacity in national and international markets. It has been established that windfarms connected to grid not only reduce the fuel consumption but also offer firm power at the time of peak demand. Photovoltaic systems have so far been limited to small applications, as the technology is still not economical for large scale power generation in grid connected or autonomous modes. The projected capacity of RETs by 2010 are given in Table 3.1.

According to the estimates made by the REC in the mid 1980's, the potential for small hydro power (SHP) was estimated at over 5000 MW. These are concentrated in the southern states of Andhra Pradesh, Karnataka and Tamil Nadu where the potential was placed at 2000 GWh of energy annually at 500 sites. Since majority of micro hydel schemes (upto 1 MW) cost less than Rs. 10 million, the SEBs/state governments themselves are allowed to sanction projects and implement them.

SHP is presently perceived to be both unreliable and a high cost option among those responsible for decision making in the Indian energy sector. The initial batch of small hydro schemes in India were conceived, designed and executed as scaled down versions of large conventional hydro installations. As a result, there are

Table 3.1: Projected capacity/installations of RETs by 2010

Technology	Capacity
Windfarms	500 MW
Mini/small/micro hydel	850 MW
Gasifier based power generation	50 MW
Photovoltaic systems	60 MW
Biogas plants	
- 2 cubic meters	43,64,000 (numbers)
- 4 cubic meters	42,44,278 (numbers)

numerous redundancies in the design for key features and the costs are high.

The reliability of SHP can be substantially enhanced through innovative and interlinked design of small hydro facilities (such as design of small hydel project based on principle of cascade development). A recent World Bank survey of the designs of small hydro facilities reveals the possibility of bringing down the unit cost to one-third of the current costs by a combination of design modification and standardization of equipment (water turbine-generator combinations) through establishing technical specifications.

Total capacity of 500 MW of windfarms has been projected to be installed by 2010. The major constraints to installing windfarms are availability of funds, logistics, global wind turbine turn over capacity and experienced and adequate manpower for preparation of specific project details. Wind turbines are not indigenously manufactured at present and only about 500 MW capacity was produced world-wide during the last decade. In order to encourage private sector participation in wind farming, the government has allowed 100 percent depreciation in the first year and wheeling of energy generated to the industry's plant.

3.3 Energy conservation

In view of the growing demand-supply gap, and the resource constraint, we need to move away from the traditional view of adding new capacity to meet the demand and instead look at demand management options. These options are often more economical compared to the cost of adding new capacity. Load management includes load reduction (conservation) as well as load shift from peak to off-peak hours, so as to maximise the utilisation of existing capacity and keep the growth rate in the requirement of peaking capacity as low as possible. The emphasis on these options will increase in future considering the fact that issues relating to global warming will predominate in the coming decade.

3.3.1 Role of pricing in load management

In India, till now, load management has been only by way of administrative measures. These include imposing power and energy restrictions, peak period restrictions, roistering the supply to different feeders, staggering of working hours and holidays in industries etc. Apart from these planned measures, unscheduled load shedding also occurs. Though these administrative measures are relatively easily to implement, they have certain negative implications. For instance, the unscheduled load shedding and voltage fluctuations could result in production inefficiencies, production losses and damage sensitive equipment.

Time-of-day tariffs is one of the pricing options that can be used to encourage the consumers to shift load from peak hours to off-peak hours. Under the tariff structure based on time-of-use, electricity consumed during peak hours is charged at a higher rate as compared to that during off-peak hours. In India, there has so far been no major attempt to experiment with time-differentiated tariff. Tamil Nadu Electricity Board (TNEB) was one of the early utilities, to initiate experiments in the area of two-part tariffs. In 1987, TNEB issued orders for implementing time-of-day pricing amongst HT consumers. The energy consumed in night in excess to

that consumed during the day was charged at a concessional rate of one fourth of the original rate. It is reported that 500 HT industrial consumers shifted their load and total savings to the Board was of the order of 150-180 MW. In 1989, however, because of severe power shortages, this order was withdrawn. Gujarat State Electricity Board (GEB) has also introduced peak load pricing for HT industrial consumers. An additional charge of 10p/KWh is levied on consumption during the peak periods i.e. 0700 hrs - 1100 hrs and 1700 hrs - 2100 hrs.

One of the major constraints in implementing time-of-use tariffs is the cost of special meters, that are required measure the demand (kW) and energy (kWh) during different hours of the day. One of the manufacturers of electronic meters in India is secure Energy Metering System (SEMS). SEMs meter can store half hourly energy consumption data for a period of about 40 days. These meters are presently priced at Rs 35,000 to 40,000 per meter. Obviously, there is a trade-off involved in the selection of the consumer category to whom TOU pricing can be applied; the costs of metering (and allied expenses) have to be weighed against the (expected) benefits of TOU pricing by way of reduced peak demand of the system. The experience of the pioneers in TOU pricing has shown that it can be gainfully applied to large industrial consumers; this is so for two reasons: Firstly, metering and associated costs of TOU pricing are likely to be a small proportion of the total electricity bill of the consumer concerned; and secondly, there is a greater possibility of shifting consumption from peak to off-peak hours in the case of industrial consumers than in the case of other categories especially domestic/commercial consumers. The utilities in India may however, initiate TOU tariffs for HT-industrial consumers on an experimental basis using a simple control circuit along with the conventional meters. A simple time switch alternatively switches on and off the two mechanical consumed during different line period - peak and off-peak. The cost of such an arrangement is much less compared to that of modern electronic

meters.

All the utilities in India except HPSEB have increasing block tariffs for domestic and commercial consumers. In the increasing block tariff structure, the lowest consumption block is charged the lowest rate and the rate increases as the consumption increases. The main objective behind this is to give subsidy to poorer consumers and to discourage high consumption of electricity. Increasing block tariffs in force in some of the SEBs in India are given in Annexure 3.5.

In the agriculture sector, the option is to move away from the flat-rate tariffs based on horse power of the pumpsets, which give no incentive at all to the farmers to conserve power. However, because of strong political lobby, boards have not been successful in doing so. As a consequence there is large misuse and wastage of precious electricity.

3.3.2 Energy efficient lighting

In the domestic and commercial sector there exists a very strong case for substituting low efficacy incandescents with high efficacy fluorescents, the criteria being that existing lumen levels should be maintained. Boer (1983) pointed out that savings upto 80 per cent are possible by using energy efficient lighting systems coupled with optimization in the design of lighting systems. Estimates made by EPRI's Energy Management and Utilization Division (USA) show that 50 per cent of the total energy consumed in lighting could be saved through energy efficient technology, without imposing any hardships on production, comfort and safety levels. In a recent study conducted by TERI on a central government office building, it was observed that lighting used about 33 per cent of the annual energy requirement and that upto a third of the present energy used for lighting could be saved by switching over to more efficient lighting systems. Thus replacement of incandescent lamps by fluorescent tube lights on a mass scale,

in domestic and commercial sector can contribute effectively to a reduction in demand from these sector.

A new generation of compact flourescent lamps have been in use in Europe and Japan since last 7 to 8 years. These lamps are energy efficient and have good colour rendering properties which makes it suitable for use in domestic and commercial applications. Compact fluorescent lamps use only one-fourth of the energy used by incandescents and consumption and peak demand. These lamps hold a lot of potential for the Indian lighting environment.

There is a very strong case for increased use of high efficacy fluorescent. In the area of street lighting, significant amount of energy can be saved by converting street lights from incandescent to fluorescent; there is even stronger case for switching over from high pressure mercury vapour (HPMV) to high pressure sodium vapour (HPSV) lamps. A switch over from HPMV to HPSV lamps, would result in: (a) roads being lit with a smaller number and lower wattage of HPSV lamps providing the same amount of illumination on the roads; or (b) an increase in the level of illumination by possibly keeping the same level of connected load.

3.3.3 Energy efficient appliances

Increase in incomes, increasing access to electricity, technological developments have all contributed to the increased use of electricity in the domestic and commercial sectors. Appliances which were considered expensive in the early seventies, are now available at affordable prices to consumers. The production of refrigerators has almost tripled during the last decade, while the production of TV sets has shown an eleven fold increase. Similarly all the other domestic appliances have shown a steady increase in production during the eighties. Therefore, the issue of domestic appliances efficiency has become all the more important, in addition to industrial energy efficiency.

Some tests conducted in TERI show that there is wide range of energy consumption in certain appliances like air conditioners and refrigerators. In the 165 litre capacity refrigerators, the average consumption was 1.89 kWh/day while the best figure was 1.27 kWh/day and the worst was 3.12 kWh/day. Similarly in the case of 1.5 tonne air conditioners, which is the most popular capacity in India, the average instantaneous consumption was 2.17 kW compared to the best and worst figures of 1.58 kW and 2.71 kW respectively.

In agriculture sector, the efficiency of pumpsets is generally low and in many cases is found to be below 30 percent. Surveys carried out have indicated that about 90 percent of the agricultural pumpsets installed are inefficient and consume about 150-200 percent more of electricity needed for properly selected pumpsets. This is partly because to save initial costs farmers buy poorly designed pumpsets and partly because the pump is often too large for the duty it performs. Though minimum standards for efficiency of pumpsets have been drawn by the Bureau of Indian Standards and also included in the terms and conditions of lending institutions, it is rarely followed in practice.

Some of the SEBs have taken appropriate steps to ensure that capacitors are installed on pumpsets. In RSEB, no new connections above 3 HP are given unless shunt capacitors of appropriate ratings are installed to the entire satisfaction of the Board. In KSEB, agricultural consumers who have not installed BIS approved capacitors the tariff rates are higher by 20 percent on both fixed and energy charge.

In view of the above observations it is important that energy efficiency standards must necessarily be devised for the various electrical appliances. Consumers prefer to buy appliances which have lower initial costs and tend to ignore the higher energy bills that they may have to pay rather than going in for energy efficient appliances, which may cost more initially, but save on energy

bills. This awareness is yet to come. There is also the need to impress upon the consumers that saving energy is the best option in the long run for both the consumer and the economy.

3.3.4 Government's role in energy conservation

The energy conservation cell in the Department of Power, Ministry of Energy, formulates policy, designs the energy management programme and ensures effective coordination between the different ministries and other organizations. The Energy Management Centre (EMC) is the executive agency responsible for implementing and monitoring energy conservation programmes. A joint Indo-UNDP and Indo-European Community programme of energy audits is also implemented through EMC.

Activities of EMC include promoting energy audits and providing recommendations to improve energy efficiency, organising sector specific campaigns for the main energy consuming sectors (industry, agriculture, commercial and government buildings), conducting training programmes in the area of energy conservation for energy managers, supervisors, shop floor workers and SEB personnel, and assisting energy conservation (EC) cell in coordinating energy efficiency activities. Some of the SEBs have also set up EC cell headed by a Chief Engineer to promote energy conservation.

In order to encourage energy efficiency, the central government has introduced the following fiscal incentives:

(i) 100 percent depreciation in the first year on notified energy conservation equipment;

(ii) Concessional excise/customs duty on notified energy conservation equipment; and

(iii) Soft loan scheme for modernization and installation of energy conservation equipment.

Energy conservation, has not yet picked up in a big way in India. Demonstration projects on energy conservation such as energy efficient lighting, shifting of industrial load from peak to off peak period etc. must be initiated on cost sharing basis by the user and SEB. Energy audits of industries as well as thermal power stations should be undertaken and use of BIS approved/ISI marked electric equipment promoted. It is important to ensure quality checks on the appliances manufactured in the country, particularly those in small scale sector where emphasis, generally, is to produce low cost product rather than quality product. What has been lacking in the efforts to promote energy conservation is the absence of measures that would penalise wastage of electricity. Attempts should be made to lay down energy norms for various industries as well as the agricultural sector and a system of penalties should be introduced, on the other hand units which have been successful in conserving energy should be publicly honoured and rewarded.

CHAPTER 4

ELECTRICITY SYSTEMS PERFORMANCE

The overall performance of the electricity system is dependent on its technical, economic and managerial efficiencies, which in turn to a great extent are a result of the institutional and regulatory regimes. For instance, poor financial performance of the SEBs is primarily due to unremunerative tariff structures for the supply of power by the SEBs. Due to their own poor financial condition the state governments are not able to give the promised subsidy on account of commercial supply for rural electrification and agriculture. In the absence of any set regulations, tariff revisions are carried out in a very ad-hoc manner, guided more by socio-political considerations rather than financial or efficiency objectives. This chapter attempts to highlight the impact of institutional and regulatory regime on the performance of the electricity system.

4.1 Electric service supplied

Though the power sector has made tremendous progress in absolute term during the past four decades (as is evident from Chapter 3), the power industry has been unable to fulfil the primary obligation of providing quality power supply in required quantity. The power supply position in the country has moved from a power surplus state in the early seventies to the deficit one from the mid seventies onwards. During the last year of the VII Plan (1985-90), the overall energy shortage in the country was 7.9 per cent and the peak shortage was of the order of 16.7 per cent. Among the five regions, the situation was worst in the southern and the eastern regions. In the western region though the energy shortage was only 2.6 per cent, the region faced severe peak shortages (see Table 4.1 for details).

Perhaps the key reason for such shortages is the insufficiency of financial resources. However, it may be noted that since the mid-sixties, the outlay for the power sector has been rather high, at 15 to 20 per cent of the total public sector outlay (refer Annexure 4.1) and the scope for increasing its share is therefore limited. Consequently, the power industry has little choice but to enhance its internal resource generation. One of the ways to do so is restructuring tariff in line with costs of power generation and supply.

Table 4.1: Power shortages at the end of VII plan (1989-90)

Region	Energy (%)	Peak (%)
Northern region	5.3	8.6
Western region	2.6	15.3
Southern region	18.3	23.0
Eastern region	15.0	22.0
N-Eastern region	3.0	0.3
All India	7.9	16.7

Also, large power shortages within the regions, is due to lack of integrated operation of the regional grids. It is important to strengthen the powers and the responsibility of the REBs to plan the development of and operate the power systems in the most efficient and economical manner and exchange power between different state power systems in the overall regional interests.

As a result of shortages, restrictions are imposed from time to time on both peak demand and energy. The consumers who are affected the most are the industries (both LT and HT) and large commercial consumers. Often, because of socio-political considerations, low tariff agricultural consumers are supplied power at the expense of high tariff industrial consumers. Most of the SEBs, in situation of shortages, resort to roistering

arrangement for the agricultural consumers (all the agricultural feeders are divided into various groups and each group is supplied electricity for notified period of time every day). However, in practice, this arrangement is not followed very strictly and agriculture consumers are supplied power for long hours with ofcourse the usual interruptions.

In addition it may be noted that the quality of power supply is not very satisfactory. Voltage levels are very poor. There are many break downs in transmission lines and local sub-stations and it takes several days to get the fault rectified. Thus, although over 80 percent of the geographical area of the country may be having access to electricity, the quality and reliability of power supply have much to be desired.

According to the report of the Fourteenth Annual Power Survey Committee even after the envisaged capacity addition of 38,000 MW during the period 1990-95, a peak load deficit of 7.7 per cent and energy deficit of 6.2 per cent, on an all-India basis is expected. The target of 38,000 MW has already been scaled down to 23,000 MW because of resource constraints, and this will increase the deficit further. In view of the fact that capacity addition is an expensive and difficult option for a resource constraint economy like India, the only option to bridge the demand-supply gap is improvement in the technical efficiencies in generation and distribution on the supply side and increased emphasis on conservation and load management on the demand side.

4.2 Technical efficiency

4.2.1 Generation

The average plant load factor (PLF) of thermal power station in India is less than 60 percent. The performance of 500 MW and 200 MW units has been satisfactory and their PLF is higher than national average. The target group for improvement in generation from thermal units is 120/140 MW and below (refer Table 4.2). Most of these units have already logged more than 1,00,000 running hours

and their performance could only be improved through a long term rehabilitation programme.

Table 4.2 : PLF of thermal power stations

Unit Size	1987-88	1988-89	1989-90
500 MW	87.0	75.0	70.0
220/210 MW	63.7	60.7	61.7
140/150 MW	44.1	40.1	42.0
100/110 MW	40.4	49.3	47.1
70-80 MW	30.5	32.8	35.7
50-60 MW	51.8	48.3	46.0
Total	56.0	55.0	56.5

Another important fact is that there is a significant difference between the performance of the thermal units in the private, central sector and the state sector. In 1989-90, while the thermal stations operated by private utilities and central sector utilities achieved an average PLF of 69.5 percent and 62.2 respectively, the corresponding figure for SEBs was 53 percent (refer Table 4.3). One of the reasons for high PLF of NTPC owned power stations is the fact that all the units are of 200/500 MW, and are relatively new. On the other hand, SEBs have a large number of small generating units and a good number of them are quite old and worn out. The SEBs are generally reluctant to undertake plant renovation and modernization mainly for the reason that it involves extended shut-down of the plant. They find it difficult to do so in the face of pressing demand for power from agricultural and other consuming sectors. In addition to all these, most of the SEBs do not have the resources to finance R&M schemes. During the Seventh Five Year Plan, 5 per cent of the total outlay for power sector was allocated for R&M schemes. PFC also has schemes of providing loans for the R&M of power stations. However, what is important is to ensure that the funds allowed for R&M to the SEBs are not diverted by the SEBs for other purposes.

Table 4.3 : Sectorwise PLF of thermal power stations

Sector	1987-88	1988-89	1989-90
Central	63.3	62.6	62.2
Private	67.6	63.3	69.5
State	53.5	51.6	53.0
Total	56.5	55.0	56.5

In addition to R&M, there is considerable scope for realising additional generation by reducing the period of stabilization of newly commissioned units. In some cases, power plants are commissioned prematurely without the plant and equipment being fully ready for regular operation. This leads to prolonged shutdowns and delays in the stabilization of the plant. A power plant should be taken as commissioned only after the plant and equipment are fully commissioned and the performance trials are completed satisfactorily.

The inadequate attention to planned maintenance inevitably results in increased forced outage rates of thermal units. During 1988-89, the all-India average forced outage of thermal power plants was 15.3 percent due to 7313 outages. While boiler troubles continue to be responsible for highest quantum of energy loss, there is a sharp decrease in the contribution by turbine and increase in the generator troubles as a percentage of the total loss in 1989-90. The percentage of total forced outage due to different causes is given in Table 4.4.

The quality of coal available to thermal power stations has declined considerably; the average calorific value of steam grade coal being about 4600 Kcal/kg. in 1975-76 and 4000 kcal/kg after 1986-87. As a consequence, specific coal consumption per unit of electricity generated is quite high. Typically, it ranges between 0.70-0.72 kg/KWh, as against the CEA norm of 0.60 kg/KWh. With

Table 4.4 : Percentage of total forced outage loss

Cause of outage	1985-86	1986-87	1987-88	1988-89	1989-90
Boiler	38.05	31.61	33.70	39.29	35.46
Turbine	11.50	26.00	23.12	23.53	14.70
Generator	23.72	20.00	18.19	10.76	21.29
Others	26.73	22.39	24.99	26.42	28.55

deterioration in coal quality increasing amounts of oil need to be fed into the boiler. During 1989-90, specific secondary fuel oil consumptions in central sector and private utilities was 5.65 ml/kWh and 6.83 ml/kWh respectively while the state owned power station consumed 11.29 ml/kWh (refer Table 4.5 for details). While 500 MW and 200/210 MW generating units recorded 4.4 ml/KWh and 7.1 ml/KWh of specific oil consumption, for smaller units (140/150, 120, 100/110, 60 MW) it ranged between 13-20 ml/kWh.

Table 4.5: Sectorwise specific secondary fuel oil consumption

Sector	1985-86	1986-87	1987-88	1988-89	1989-90
Central	9.0	6.4	7.6	6.42	5.7
State	16.0	14.3	11.6	11.75	11.3
Private	9.3	4.7	4.6	8.10	6.8
All India	13.9	12.0	10.5	10.0	9.2

4.2.2 Transmission and distribution

Transmission and distribution losses in Indian utilities increased, on an average, from 17.5 percent in 1970/71 to 21.7 percent in 1985-86, and then levelled off to about 21.22 percent during the period 1986-87 to 1989-90 (refer Annexure 4.2). In 1990-91 the losses were of the order of 22.9 per cent. The most important reason for high T&D losses is the lack of adequate investment in T&D system. Investment in generation has always

gained priority over investment in T&D, with the prime objective of increasing supply to match the demand. An expert group set up on the power sector in 1980 recommended that 50 percent of the total plan investment should go for T&D. However, in practice, investment in generation has varied between 60-62 percent of the total investment in the power sector since the Fifth Five Year Plan (refer Annexure 4.1).

At present, transmission system planning succeeds generation planning as an independent exercise in determining the network requirements for a given generation programme and load estimates. It is necessary that T&D and generation planning is done simultaneously and in a co-ordinated way. The final choice of generation source should be based on minimising the cost of power delivered to the consumers and the level of power system reliability expected. Adequate EHT transmission system for bulk evacuation of power should be ready along with commissioning of generating capacity. In the lower voltage networks, in addition to augmenting of the network, installation of capacitors, reconductoring, eliminating both underloading and over loading of distribution transformers etc is required to reduce losses. Many utilities in India include a power factor improvement clause in their tariff schedules to minimise the loss of system efficiencies.

Non-technical/commercial losses are estimated to be quite high in several utilities in India. For instance, according to a study conducted by TERI for the Delhi Electricity Supply Undertaking (DESU), the total T&D losses of 22 per cent comprise about 13 per cent technical losses and 9 per cent commercial losses. There are several reasons for such high non-technical losses, including

(i) legal consumers tamper with meters;
(ii) pilferage of electricity by consumers who do not have a legal service connection;

(iii) a regular programme for checking, sealing, calibrating, repairing and maintaining meters is not followed vigorously due to shortage of staff and meters;

(iv) funds to replace defective meters are not available;

(v) consumers not billed on time and hence in accounting consumption not billed is taken as losses.

In contrast to technical losses, which can be minimized but never altogether eliminated, an attempt can be made to reduce the non-technical losses to a low level. This however, requires a judicious mix of legislative support, increased customer awareness, improved billing and collection procedures and reliable and high quality meters.

4.3 Balance of payments

The power sector in India, has not depended on the country's balance of payments, as the power industry is primarily dependent on indigenous coal and hydro resources for power generation and the share of diesel based generation (utilities) is very small. Liquified hydrocarbons such as LSHS & fuel oil, are required as secondary fuel to support combustion at low load operation of boiler in coal based thermal power generation. It is evident from Table 4.6 that the total consumption of petroleum products, in absolute term has remained more or less same during the period 1985/86 to 1990-91. The percentage share of fuel oil consumed in power generation, of the total consumption of fuel oil in various sectors of the economy has declined significantly from 21 per cent in 1985-86 to 11.9 per cent in 1990-91. The share of LDO and HSDO has declined marginally and that of LSHS/HHS increased from 37 per cent in 1985-86 to 40.6 per cent in 1990-91. The all-India specific consumption of secondary fuel per unit of electricity generated in Indian thermal power stations has declined from 13.9 ml/kWh in 1985-86 to 9.2 ml/kWh in 1989-90 but it is still high as per the standard (6ml/kWh) laid down by the CEA. Some of the reasons for high specific oil consumption are:

(i) poor quality of coal available to power stations, particularly during rainy season;

(ii) increased oil support is required to operate the thermal plants during night when the load on the boiler falls below 60 per cent;

(iii) 110-120 MW thermal units have high specific oil consumption because of some generic defects, their PLF being of the order of 45-48 per cent.

It is estimated that if oil consumption were to reduce to 6 ml/kWh (as specified by CEA) in 1996-97, the power sector will save about 961 thousand tonnes of LSHS/FO, which in turn can be either exported or converted into naptha which is presently being imported to reduce the dependence on imported diesel oil. Some of the power stations in the northern region located near the HBJ pipeline can be converted to use gas in place of fuel oil for supplementing combustion in boilers. Power stations at Delhi (Indraprastha, Badarpur and Dadri), Faridabad and Panipat in Haryana, Hardwaganj in U.P. and Kota in Rajasthan could be switched to natural gas as fuel.

Table 4.6: Consumption of petroleum products in power generation (utilities)

'000 Tonnes

Fuel	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
Fuel oil	804	712	636	617	692	531
	(21.1)	(18.8)	(15.2)	(13.4)	(15.4)	(11.9)
LSHS/HHS	1526	1489	1659	1571	1630	1835
	(37.3)	(35.0)	(42.0)	(40.8)	(37.6)	(40.6)
HSDO	160	161	209	132	126	104
	(1.1)	(1.0)	(1.2)	(0.7)	(0.6)	(0.5)
LDO	255	273	251	346	325	282
	(22.7)	(23.6)	(20.2)	(24.1)	(22.0)	(18.8)
Total	2745	2635	2755	2651	2773	2752

Figures in bracket give the percentage share of the fuel consumed in power generation of the total consumption in the country.

Due to high energy shortages in the country, number of industries have installed captive plants and have stand-by diesel sets. During 1988-89, 1234 industries, having a total installed capacity (captive) of 7420 MW, generated 19,881 kWh of electricity. Of the total captive installed capacity, the share of diesel based plants was 34 per cent. The details of installed captive capacity and electricity generation as on March 1989 are given in Annexure 4.3. It is evident that 35 per cent of the total captive installed capacity and 13.5 per cent of captive generation was diesel based. Use of diesel for captive generation causes a drain on the country's foreign exchange. The recent initiatives for the power sector to enter generation, if coupled with the option of selling power to a group of industries, who are the investors, should reduce the use of imported petroleum fuels for power generation.

The Indian power industry has been indigenized to a considerable extent. A programme of indigenous manufacture of heavy electrical power equipment was initiated during the mid-fifties and four power plant facilities for manufacture of hydro and steam generating units, transformers and switchgears were set up. In 1987-88, 79 per cent of the new capacity commissioned was indigenous, as compared to only 7.2 percent in 1969-70 (refer Annexure 4.4). The country has developed skill and expertise in design, manufacture and consultancy in the hydro-electric and thermal power development. Capability for manufacture of equipment required for the atomic power plants both on the nuclear reactor side and the conventional power plant side, has also been gradually built up and the reliance on imports has reduced steadily with successive plants. In the case of Kalpakkam atomic power plant, the import content was only 12 per cent and in the case of Narora it had further reduced to 10 per cent. Gas turbines of less than 50 MW capacity are being manufactured indigenously. For GTs with higher capacity, the import content is 60 per cent. In combined cycle gas plants, the steam turbine is 100 per cent indigenous and the import content of GT and waste heat boiler is almost 50 per cent.

At present, despite the resource crunch of the SEBs, and the general "capital constraint" situation of the Indian economy, financial assistance from overseas (largely multilateral/bilateral assistances) is less than 10 per cent of total power sector investments in India. In the Seventh Plan period (1985/86 to 1989/90), financial assistance from overseas in central sector projects was about 10-11 per cent of their total investments and the share in the state sector was about 8 per cent. In all bilateral contracts it has been found that the ultimate cost of the plant is much higher than the plants set up under international competitive bidding (ICB), where indigenous manufacturers are given a 15 per cent price preference. The donor country in case of bilateral contracts issues almost all plant and equipment which form about 50 per cent of the cost of the power stations being supplied by that country.

CHAPTER 5

CONCLUSIONS

The power sector in the country has undergone a substantial change, both in terms of the size of the sector, as well as in terms of the regulatory structure. This was perhaps necessary keeping in view the rapid growth in demand that the sector had to meet. The institutional setup has also changed as the sector grew. The central sector presently accounts for 22 per cent of the total installed capacity and for 25 per cent of the total energy generated in the country. This is expected to increase in the next ten years. By the year 2000, India is likely to have an installed capacity nearing 100,000 MW making it certainly one of the largest power systems in the world.

The earlier chapters have highlighted the growth in the power sector, the changes in the institutional setup, the regulatory structure, the constraints within which they have to operate and indicated some of the key areas where efforts need to be concentrated for improving the performance of the sector. This chapter summarizes some of the important problems facing the electricity system and possibly a direction towards a solution.

Integrated resource planning (IRP): The present low per-capita consumption of electricity means that the growth of 8-10 percent that has been the trend over the last two decades, will continue. The utilities continue to regard their primary role as that of supplying electricity through additions to capacity. The issues relating to managing demand through other means such as prices, demand-side management (DSM) methods has not been systematically explored. Linked to this is the absence of sophisticated computer models which could be used to demonstrate the efficacy of demand management methods. While the top management at the utilities are certainly aware in general of DSM, no systematic efforts have gone towards developing a scientific approach to DSM.

This is a two step process: firstly, a group of top management officials from selected utilities should be given a one week in-depth exposure on integrated resource planning, with specific case studies from utilities that have successfully developed and implemented them. The next step would be to move towards the development of a detailed DSM plan identifying target consumer groups and the strategies required. Utilities in Europe and USA have been successful in this regard and cooperation with them is necessary.

Environmental strategies: The pressure on maintaining emission levels and to subsequently reduce the impact on the environment will only increase globally and the developing countries may not be able to cite reasons of development for long. The need is to increase efficiency in the energy generation in order that the per-unit emissions are reduced; reduce the transmission and distribution losses which means that more can be consumed per unit of energy produced; lastly increasing efficiency of end-use will also make available same unit of electricity to a larger population. While efforts to improve efficiencies will continue internally, we need to think ahead in terms of utilizing some of the advanced technologies that are in place in Europe and USA and work towards a time-bound programme of technological advancement with the basic objective of reducing the impact on the environment.

Institutional and regulatory changes: These changes have been made from time-to-time keeping in view the need for efficiency in the operations in the power sector. The central government decided to play an important role in power generation and hence NTPC, NHPC etc. Regulatory changes have been brought about to permit the entry of the private sector into the field of power generation with twin objectives of bringing in additional resources, and possibly to bring in increased efficiencies. These changes have been recent and the impact of these changes is yet to be seen. The investments required by the private sector would be large; a 500 MW station

would require a total investment of Rs. 8 billion, of which the private sector is expected to bring in Rs. 4.8 billion. The private sector has as yet made forays of this order in fertilizer, steel and petrochemicals. Except for the private sector licensees in Bombay, Calcutta and Ahmedabad who have been in existence for the last three decades, no new licenses have been granted. While several private parties have expressed interest in this area, discussions are still ongoing between the SEBs and the private parties, and it is still early in the day to comment on the impact of this regulatory change.

There are several concerns being expressed. Firstly, the long delays that exist in getting the several clearances required to setup projects; secondly, uncertainty in supply of fuel (coal, gas); thirdly, uncertainty in being paid for power sold; and last (but not the least of all) the price of power and uncertainty in the SEBs purchasing power generated by the private utility. The SEBs do not have a good record of paying on time and that is certainly causing concern amongst the private investors.

There is perhaps a need for an independent commission or body to coordinate all aspects of the power sector operations, the more important among them being prices, and in ensuring decisions of power purchase efficient generation is a key criteria. The Rajadhyaksha Committee on Power in 1980 had suggested the formation of a National Bureau of Electricity Costs and Prices, which would function along the lines of the existing Bureau of Industrial Costs and Prices, but with more autonomy and more statutory powers to fix prices and control costs. Further work in this area is required.

Role of renewables in power sector: The technology for renewables has advanced substantially over the last decade. Renewables such as wind, and photo-voltaic systems have made inroads into supplying electricity to the grid and have proved their reliability in different parts of the world. While it is agreed that renewables

may not be able to contribute in quantities similar to conventional power generation systems, they must be utilized wherever potential exists for their utilization. The grid is constantly expanding into the interior at a heavy cost, and this is an area where decentralized renewable systems can perhaps contribute. The Department of Non-Conventional Energy Sources has taken the lead in introducing these systems in the interior parts of the country. The power sector should take this into account while drawing up plans for electrifying interior parts of the state. This can be introduced in the planning process through the integrated resource planning. Renewables have the added advantage of having little or no impact on the environment.

Distribution planning: Studies have shown that the bulk of losses in transmitting the power from generation to the consumer is in the distribution system (11kV and below). The demand for power in the smaller towns and cities have been growing at 10-12 percent and the distribution system has not been able to keep pace with this rapid growth. System breakdowns are quite frequent and interruptions to supply inevitable. There is an urgent need to plan the growth in distribution systems in a more scientific manner in order to not only minimize the losses but also to improve the overall reliability of the system. Optimization of transformer sizes and locations, planning layout of distribution lines, conductor sizing are some of the areas that need to be looked into. The practices adopted in some of the developed countries such as France, Germany would be of immense help in reducing the distribution losses.

General management: The utilities have grown in size from single station generation, load center based utilities to multi-station, multi-fuel generation, transmission and distribution utilities. There are several utilities with capacities of over 5000 MW and with an asset base of over Rs. 100 billion and annual revenue of the order of Rs. 20 billion. The area of coverage runs into several thousand sq. kms. and they have offices spread across vast expanse

of the state. In this process, management and control of this asset base has meant employment to thousands of employees. Even within the utility, there are some areas where there is a shortage of manpower, while there is a surplus on some other areas. The utilities have become known for their over-staffed positions and there exist opportunities for rationalization and control in this area.

There also exist scope for improvement in other general management areas such as project execution, inventory control, billing and collections, procurement etc. There is also a need to look into aspects of human resource development, into technical training at various levels and opportunities for growth of professionals within the board. All these are area which are within the direct purview of the board and are areas where initiatives could be taken by the board.

The power sector faces an immense responsibility to meet the rapidly growing demand for power in the country. While regulatory and institutional reforms can certainly improve the environment for the public utilities and the private companies to operate, improvement in operating efficiencies necessarily have to come from within. This is the key to delivering the power required in the coming decades.

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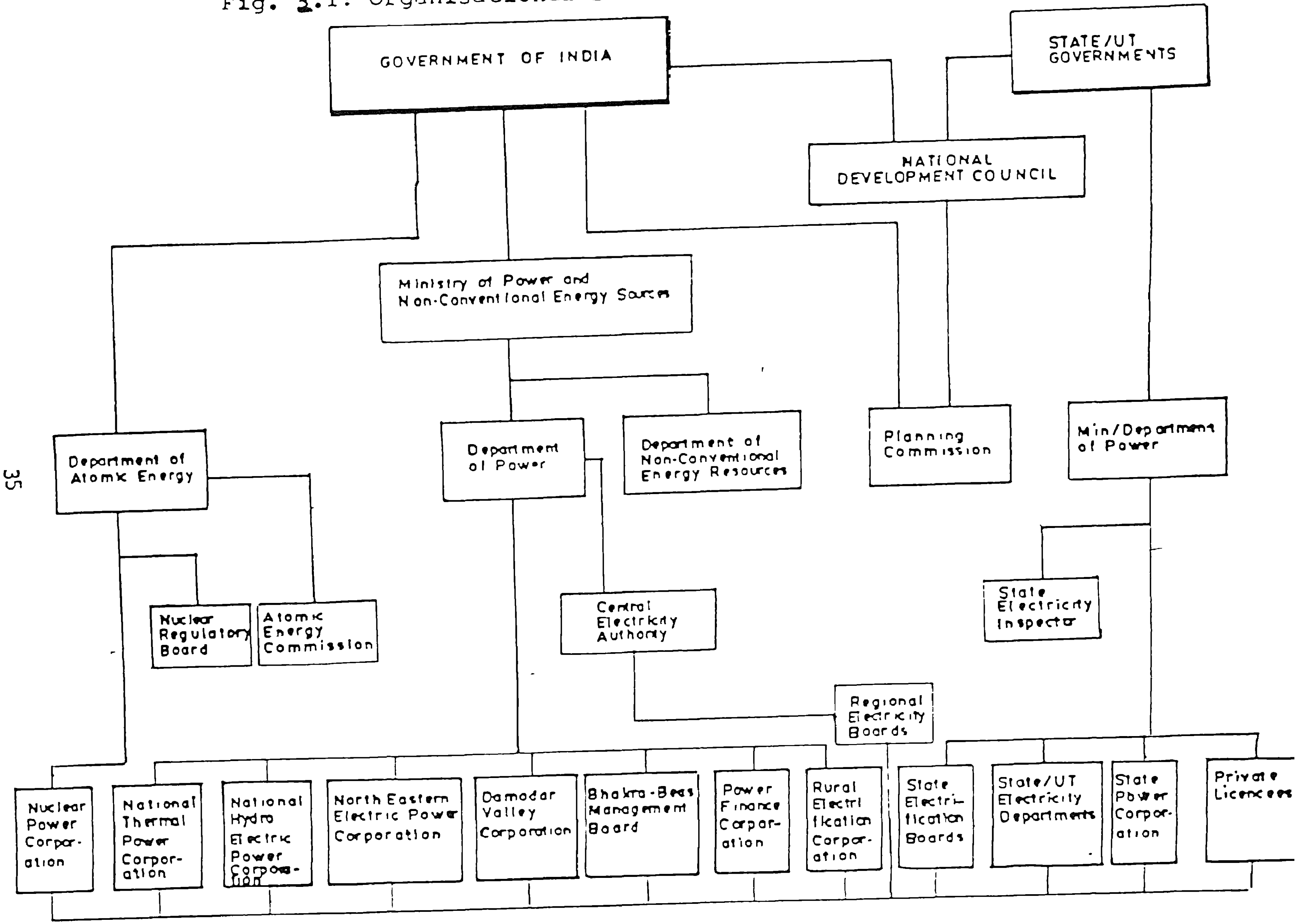
Fig. 3.1: Organisational Structure of the Power Sector



Trends in installed capacity - ownershipwise (MW)

Year	SEB	EDs	Munici-palities	Private Companies	Total Utility
1960-61	2604	524	95	1356	4579
	(56.8)	(11.4)	(2.1)	(29.6)	
1971-72	10005	3507	257	1485	15252
	(65.6)	(23.0)	(1.7)	(9.7)	
1975-76	13913	4600	301	1302	20116
	(69.2)	(22.0)	(1.5)	(6.5)	
1980-81	23456	5101	276	1382	30215
	(77.6)	(16.9)	(0.9)	(4.6)	
1985-86	33614	10732	257	2165	46769
	(77.8)	(23.0)	(0.5)	(4.6)	
1987-88	36331	15316	417	2091	54155
	(67.1)	(28.3)	(0.7)	(4.6)	
1988-89	38074	18281	484	2201	59040
	(64.5)	(31.0)	(0.8)	(3.7)	

Annexure 1.2

Trends in energy sales - ownershipwise (MW)

Year	SEB	EDs	Munici-palities	Private Companies	Total Utility
1960-61	31277	3536	2583	9557	47053
	(66.5)	(7.5)	(5.5)	(20.5)	
1971-72	43656	4180	3024	9385	60245
	(72.5)	(6.4)	(5.0)	(15.6)	
1975-76	64662	4095	4226	9383	82366
	(78.5)	(5.0)	(5.1)	(11.4)	
1980-81	99363	5986	6135	11515	122999
	(80.7)	(4.9)	(5.0)	(9.4)	
1987-88	119796	6470	6976	12470	145612
	(82.3)	(4.4)	(4.8)	(8.5)	
1988-89	133134	6815	7385	12866	160200
	(83.1)	(64.3)	(4.6)	(8.0)	

Details of major clearences required for setting up a project in the Power sector

Statutory Clearances	Clearing Authority
1. Cost Estimate Section 29 (1)	Central Electricity Authority (CEA)
2. Techno-Economic Clearance	Central Electricity Authority (CEA)
3. Publication 29 (2)	State Government
4. Water Availability	Central Water Commission/State Govt
5. SEB Clearance	SEB/State Govt.
6. Pollution Clearance (Water & Air)	State/Pollution Control Board
7. Forest Clearance	Ministry of Environment & Forests/State Govt
8. Environment & Forest Clearance	Ministry of Environment & Forests/State Govt
9. Civil Aviation Clearance for Chimney Height	National Airport Authority
10. Company Registration	Registrar of Companies
11. Rehabilitation & Resettlement of Displaced Families by Land Acquisition	Ministry of Environment & Forests/State Govt
12. Hydel Projects	Ministry of Water Resources
13. Equipment Procurement	DGTD, CCI&E
Non-Statutory Clearances	
14. Land Availability	State Govt
15. Fuel Linkage	Dept. of Coal,Dept. of Petroleum & Natural Gas
16. Financing	CEA/DOP/Dept. of Economic Affairs/ Financial Institutions
17. Transporatation of Fuel	Depts. of Coal/Pet&natural Gas/Min.of Railway, Shipping & Surface Transport

Annexure 2.2

Indian Air Quality Standards

A. Ambient Standards

Area classification	8 hr avg. concentration ug/cu.m not to be exceeded 95 % of time in a year		
	TSP	NOx	SO2
Industrial and mixed use	350	120	120
Residential and/or rural	200	80	80
Sensitive or protected	100	30	30

B. Standards for particulate emissions (mg/cu.m)

Boiler size	Old plants (pre 1979)	New plants
< 200	600	350*
> 200		150

Annexure 2.3

Minimal National Standards for wastewater from thermal power plants

A. National standards for condenser cooling waters (once through cooling systems)

Parameters	Max. limiting concentration
pH	6.5 - 8.5 (not more than 5 % higher than the intake water temperature)
Free available chlorine	0.5 mg/liter

B. National standards for boiler blowdowns

Parameters	Max. limiting concentration (mg/liter)
Suspended solids	100
Oil and grease	20
Copper (total)	1
Iron (total)	1

C. National standards for ash pond effluents

Parameters	Max. limiting concentration (mg/liter)
pH	6.5 - 8.5
Suspended solids	100
Oil and grease	20
No limits for heavy metals at present	

Pattern of financing capital expenditure (1989-90)

Board	Market borrowing	Institut -tional sources	Internal resources	Residual sources*	Total
Andhra Pradesh	0.0	13.8	20.9	65.2	100.0
Assam	40.6	19.6	-93.9	133.8	100.0
Bihar	33.1	47.4	-89.1	108.6	100.0
Gujrat	12.5	56.0	-50.6	82.1	100.0
Haryana	11.9	43.4	-88.0	132.7	100.0
Himachal Pradesh	20.0	77.0	-49.8	52.8	100.0
J&K	13.8	31.0	-62.2	117.4	100.0
Karnataka		34.0	-18.6	84.5	100.0
K.P.C		32.8	-34.1	101.3	100.0
Kerala	6.9	29.8	18.3	45.0	100.0
Madhya Pradesh	15.3	48.7	19.9	16.1	100.0
Maharashtra	13.2	30.5	0.0	56.3	100.0
Meghalaya	56.6	87.4	-57.5	13.5	100.0
Orissa	14.0	76.0	-0.7	10.7	100.0
Punjab	7.3	13.1	-33.8	113.4	100.0
Rajasthan	14.1	30.4	-19.4	74.9	100.0
Tamil Nadu	13.5	51.1	-94.4	129.8	100.0
Uttar Pradesh**	6.4	48.9	-40.5	85.2	100.0
West Bengal	23.2	64.4	-11.0	23.4	100.0
Total (SEBs)	12.8	40.6	-30.6	77.2	100.0

*: Mainly State Government loans

Annexure 2.5

Debt service ratios of state electricity boards

Board	1988-89	1989-90	1990-91
Andhra Pradesh	1.25	1.60	1.07
Assam	-0.14	-0.21	-0.08
Bihar	-0.31	-0.44	-0.28
Gujrat	0.27	0.05	0.00
Haryana	0.20	-0.24	-0.40
Himachal Pradesh	0.27	0.18	0.27
J&K	-0.86	-1.02	-0.95
Karnataka	0.52	0.42	0.22
K.P.C	0.69	0.73	0.69
Kerala	0.38	0.72	0.56
Madhya Pradesh	0.79	0.87	0.81
Maharashtra	0.50	0.48	0.52
Meghalaya	0.35	0.15	0.13
Orissa	0.38	0.81	0.85
Punjab	0.01	-0.15	-0.17
Rajasthan	0.41	0.22	0.08
Tamil Nadu	-0.49	-0.52	-0.65
Uttar Pradesh	0.02	0.05	0.10
West Bengal	0.03	0.02	-0.11
All Boards Average	0.25	0.22	0.18

Annexure 2.8

Commercial profit(+)/losses(-) (excluding subsidies)

Board	1985-86	1986-87	1987-88	1988-89	1989-90	1985-90	1990-91
Andhra Pradesh	-9.65	-53.87	29.30	42.02	41.91	49.71	22.14
Assam	-112.51	-141.93	-146.23	-179.82	-222.98	-803.47	-245.48
Bihar	-188.82	-229.43	-295.11	-287.81	-208.09	-1209.26	-222.91
Gujrat	-115.73	-76.74	-153.89	-170.66	-262.89	-779.91	-309.31
Haryana	-78.03	-94.58	-172.97	-109.58	-190.21	-645.37	-244.69
Himachal Pradesh	-4.28	-3.83	-22.92	-18.58	-19.16	-68.77	-61.49
J&K	-40.66	-49.66	-68.32	-73.68	-103.21	-335.53	-114.56
Karnataka	-26.73	-74.45	-104.49	-46.39	-70.1	-322.16	-115.82
K.P.C	-24.11	-12.32	-32.79	-26.68	-27.47	-123.37	-33.92
Kerala	4.83	-16.34	-48.27	-52.19	-26.44	-138.41	-48.46
Madhya Pradesh	-42.89	-23.82	-78.50	-101.21	-84.48	-330.90	-125.01
Maharashtra	-57.43	54.00	47.31	-192.5	-258.12	-406.74	-283.13
Meghalaya	-3.28	-10.12	-4.49	-10.99	-18.18	-47.06	-25.9
Orissa	-22.70	-18.61	-62.35	-49.84	-5.87	-159.37	4.55
Punjab	-144.97	-216.03	-345.15	-423.56	-602.55	-1732.26	-755.81
Rajasthan	-62.88	-43.63	-126.43	-108.49	-175.24	-516.67	-246.64
Tamil Nadu	-182.83	-145.47	-223.42	-327.19	-477.85	-1356.79	-635.35
Uttar Pradesh	-359.49	-386.66	-451.65	-543.79	-635.79	-2377.38	-702.14
West Bengal	-92.87	-84.59	-121.51	-144.46	-170.26	-613.69	-210.26
Total (SEBs)	-1565.03	-1628.08	-2381.88	-2825.4	-3516.98	-11917.4	-4354.19

Annexure 3.1

Installed capacity in utilities - primemoverwise

Year	Hydro		Thermal		Nuclear		Total
	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)
1950	559.29	32.65	1153.23	67.34			1712.52
1955	939.48	34.86	1755.34	65.13			2694.82
1960-61	1916.66	41.19	2736.39	58.80			4653.05
1965-66	4123.74	45.68	4903.28	54.31			9027.02
1970-71	6383.23	43.39	7905.73	53.74	420.00	2.85	14708.96
1975-76	8463.60	42.07	11013.46	54.74	640.00	3.18	20117.06
1980-81	11791.22	39.02	17563.43	58.12	860.00	2.84	30214.65
1985-86	15471.60	33.08	29967.43	64.07	1330.00	2.84	46769.03
1986-87	16195.64	32.80	31740.22	64.42	1330.00	2.69	49265.86
1987-88	17215.09	31.70	35650.22	65.65	1330.00	2.44	54195.31
1988-89	17586.40	29.51	40671.50	68.25	1330.00	2.23	59587.90
1989-90	17999.10	28.71	44700.50	69.81	1330.00	2.08	64029.60
1989-90	18443.00	28.45	44910.00	69.29	1465.00	2.26	64818.00

Annexure 3.2

No. of thermal units in different capacity groups (as on 31.3.89)

Capacity group	Number of units	Capacity group	Number of units
500	5	70/80	7
200/210	78	67.5/62.	38
140/150	9	60	25
120	20	50/55	28
110	35	20/40	25
100	11		

Annexure 3.3

Transmission and distribution system by region (ckt. km.)

Region	Total	400 KV	220 KV 132 KV 110 KV	66 KV 33 KV 22 KV	11 KV 6.6 KV 3.3 KV	0.4 KV
(a) As on 31 March 1981						
Northern	732604	1427	24984	50050	272446	383697
Western	656115	913	28619	63251	199828	363504
Southern	847199		23467	47538	193951	582243
Eastern	247908		12665	21842	104999	108402
Northeastern	38635		1837	7953	13289	15556
Total	2522461	2340	91572	190634	784513	1453402
(b) As on 31 March 1988						
Northern	1048633	3470	35152	59822	373520	576669
Western	1081423	4938	39054	77230	330441	629760
Southern	1235389	628	36347	60144	271391	866879
Eastern	349356	387	20253	25973	149156	153584
Northeastern	77306		3260	10177	31655	32214 *
Total	3792107	9423	134066	233349	1156163	2259106 *

Length of 22 KV, 6.6 KV 3.3KV lines is very limited

Annexure 3.4

Sectoral shares in electricity consumption (percent)

Year	Domestic	Commercial	Industry	Agriculture	Others
1950-51	12.4	6.9	63.8	4.2	12.8
1960-61	10.7	6.1	69.4	6.0	7.8
1965-66	8.8	6.2	70.6	7.1	7.3
1970-71	8.8	5.9	67.6	10.2	7.5
1975-76	9.7	5.8	62.4	14.5	7.6
1980-81	11.2	5.7	58.4	17.6	7.1
1985-86	14.0	5.9	54.5	19.1	6.5
1988-89	15.2	6.2	47.1	24.5	6.7
1989-90	16.1	5.8	46.3	25.0	6.6

Electricity tariffs : domestic & commercial sector (as on 31.12.90)

SEB	Domestic Sector	Commercial sector
HSEB	0-40 KWh - 40 41-100 KWh - 60 101-200 KWh - 75 >200 KWh - 100	0-30 KWh - 90 31-80 KWh - 95 > 80 KWh - 100
HPSEB	0-25 KWh - 45 >25 KWh - 40	0-100 KWh - 90 > 100 KWh - 120
PSEB	0-25 KWh - 53 26-100 KWh - 75 > 100 KWh - 102	0-100 KWh - 122 > 100 KWh - 132
MPSEB	0-100 KWh - 40 101-200 KWh - 42 > 200 KWh - 50	0-200 KWh - 90 > 200 KWh - 105
MSEB	0-30 KWh - 50 31- 150 KWh - 80 > 150 KWh - 105	0-100 KWh - 120 > 100 KWh - 155
APSEB	0-100 KWh - 60 > 100 KWh - 70	130 paise/Unit
KEB	0-250 KWh - 60 > 250 KWh - 80	0-50 KWH - 140 > 50 KWh - 175
BSEB	0-50 KWh - 44 > 50 KWh - 50	0-100 KWh - 79 > 100 KWh - 90
WBSEB	0-50 KWh - 52 51-100 KWh - 60 100-300 KWh - 70 >300 KWh - 100	0-50 KWh - 80 51-100 KWh - 90 101-300 KWh - 125 > 300 kWh - 140

Annexure 4.1

Trends in investment in Power Sector - categorywise, planswise

Plan period	States/ UTs/Total	Generation	T&D	R.E	R&M	Misc.	Total outlay for power	Overall plan outlay
Second	Total	235.00	117.00	75.00	-	-	427.00	4600.00
Third	Total	712.00	327.00*	-	-	-	1039.00	8576.00
Fourth	States	974.06	645.51	285.15	-	14.35	1919.07	
	UTs	25.48	44.27	9.54	-	2.49	81.78	
	Centre	255.10	31.80	150.00	-	9.82	446.72	
	Total	1254.64	721.58	444.69	-	26.66	2447.57	15778.08
Fifth	States	3722.71	1897.73	674.56	-	74.94	6369.92	
	UTs	6.52	78.78	10.74	-	2.72	98.76	
	Centre	665.24	104.74	-	-	55.24	825.22	
	Total	4394.47	2081.25	685.30	-	132.88	7293.90	39426.82
Sixth	States	8000.00	4549.00	1560.00	-	184.00	14293.00	
	UTs	59.00	159.00	17.00	-	12.00	247.00	
	Centre	3755.00	713.00	-	-	257.00	4725.00	
	Total	11814.00	5421.00	1577.00	-	453.00	19265.00	109645.08
Seventh	States	13254.67	6779.66	2091.95	392.06	168.42	22688.76	
	UTs	54.92	424.34	16.05	27.85	12.00	535.16	
	Centre	7993.04	1994.00	-	552.00	512.50	11051.54	
	Total	21302.63	9198.00	2108.00	971.91	692.92	34273.46	180000.00

T&D - Transmission and distribution
R.E - Rural electrification
R&M - Repairs and maintenance

Annexure 4.2

Trends in transmission and distribution losses
(including unaccounted commercial losses in utilities)

Year	T&D losses (%)	Year	T&D losses (%)
1950-51	14.80	1985-86	21.74
1960-61	14.60	1986-87	21.74
1970-71	17.90	1987-88	22.48
1980-81	20.56	1988-89	23.25
1981-82	20.71	1989-90	21.90
1982-83	21.14	1990-91	20.45
1984-85	21.47		

Installed generating capacity and generation of industries having captive plants of 1 MW and above (as on 31.3.89)

Region	Number of industries	Steam	Diesel	Hydro	Gas	Total
Installed capacity (MW)						
- Northern region	346	898.96	713.66	-	38.00	1650.62
- Western region	328	1138.29	642.39	-	152.82	1933.50
- Southern region	366	542.59	722.30	3.60	7.14	1275.63
- Eastern region	182	1841.01	419.95	-	51.15	2312.11
- N-eastern region	12	95.00	83.04	-	70.00	248.04
- All India	1234	4515.85	2581.34	3.60	319.11	7419.90
Generation (GWH)						
- Northern region	346	4081.33	687.89	-		4769.22
- Western region	328	4497.53	345.38	-	524.19	5367.10
- Southern region	366	1470.83	1391.98	16.45	17.87	2897.13
- Eastern region	182	6015.88	290.97	-	15.47	6322.32
- N-eastern region	12	248.66	69.91	-	306.6	625.17
- All India	1234	16314.23	2786.13	16.45	864.13	19980.94

Annexure 4.4

Share of indigenous power generation capacity in the capacities commissioned

Year	Total capacity commissioned (MW)	Indigenous equipment			% of the indigenous capacity in the total capacity commissioned
		Hydro (MW)	Thermal (MW)	Total (MW)	
1969-70	1243	-	90	90	7.20
1970-71	697	96	60	156	22.38
1971-72	647	63	156	213	32.90
1972-73	1018	15	90	105	10.30
1973-74	554	26	320	346	62.50
1974-75	1725	286	930	1216	70.50
1975-76	1800	720	770	1490	82.77
1976-77	1712	412	860	1272	74.28
1977-78	1957	755	1140	1895	96.88
1978-79	3022	725	2210	2935	97.12
1979-80	1799	394	1150	1544	85.82
1980-81	1823	307	1190	1497	82.00
1981-82	2175	380	1630	2010	92.00
1982-83	3060	840	2010	2850	93.00
1983-84	4088	760	2955	3715	91.00
1984-85	3080	400	2202	2602	84.00
1985-86	4219	742	2330	3307	78.40
1986-87	2629	549	1510	2059	78.00
1987-88	4973	958	2990	3948	79.40